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Hydrology Report

Hammerhorn Campground Restoration and Salvage

Covelo Ranger District, Mendocino National Forest
Mendocino County, Ca

Hammerhorn Lake Dec 2021.

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Executive Summary

The purpose of this document is to characterize hydrology resources of the Hammerhorn Campground Restoration and Salvage Project and analyze any potential effects from implementing the no action and action alternatives.

Methodology

The analysis of alternatives is based on field observations and an assessment of the Cumulative Watershed Effects (CWE) resulting from activities planned or expected to occur under each of the alternatives.

Watershed effects as a result of the proposed project have been analyzed using the Cumulative Watershed Effect (CWE) process (as required by USDA FSH 2509.22, Soil and Water Conservation Handbook, Chapter 20- Cumulative Off-Site Watershed Effects Analysis). This analysis considers all ground-disturbing activities (past, present, and foreseeable future) including: past wildfire, prescribed fire, vegetation treatments, grazing, non-Forest Service timber activities, and roads.

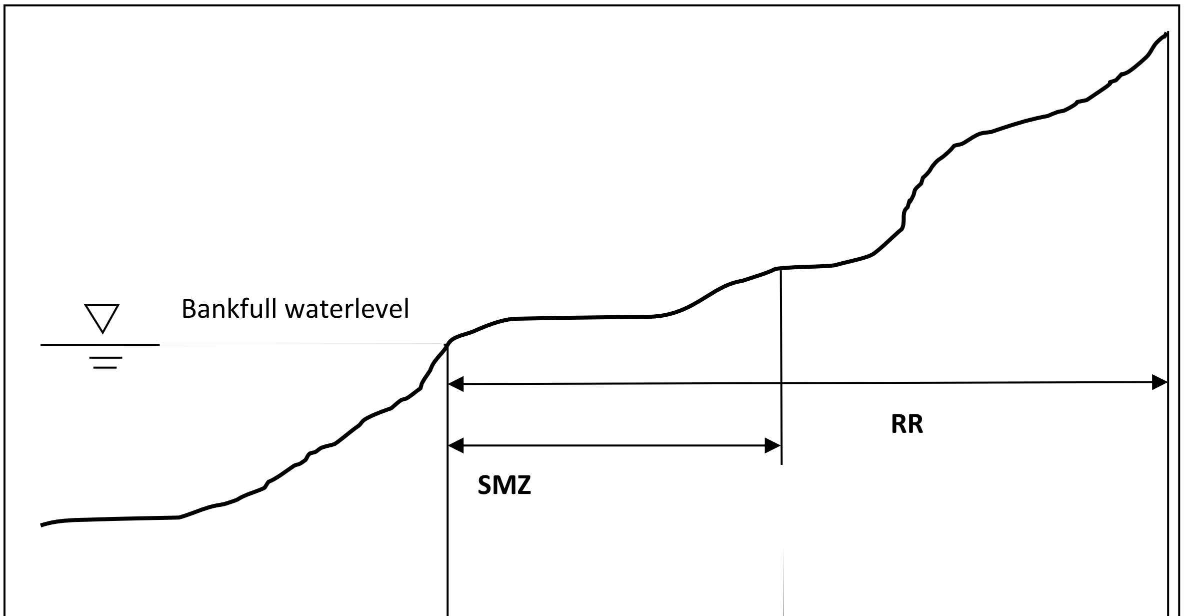
Spatial boundaries for the CWE analyses include 7th field (HUC 14, approximately 2,000-10,000 acres). These watersheds are 2nd to 4th order streams. Temporal Bounding of the CWE analysis considers all ground-disturbing activities in the past (up to ten years prior), present, and reasonably foreseeable future.

Details on the CWE analyses can be found in this Hydrology Report under the Cumulative Effects section of Alternative 2.

Affected Environment

The planning area is approximately 11,400 acres while the project units (where ground disturbing activities will take place) only includes 250 acres, within the border of the Mendocino National Forest (MNF). The project is located within the Hammerhorn, Buck Rock and Smokehouse - 7th field watersheds.

The project units encompass about **89** acres of Riparian Reserves (RRs), and approximately **57** acres of Streamside Management Zones (SMZs). RRs and SMZs constitute a hierarchy of areas designated to protect water quality, aquatic and riparian habitats. The highest level of protection occurs within the SMZ, where no ground-based mechanized equipment are allowed to operate except at designated crossings.



RR and SMZ width for each stream class (this is for both sides of stream):		
Streamclass	Riparian Reserve Buffer	Streamside Management Zone Buffer
Perennial	300’	The greater of 100’ slope distance or to the slope break
Perennial (fish bearing)	300’	The greater of 200’ slope distance or to the slope break
Intermittent	200’	The greater of 100’ slope distance or to the slope break
Ephemeral	100’	The greater of 100’ slope distance or to the slope break

Environmental Consequences

The environmental consequences section describe effects of the proposed project to watershed resources. Discussion regarding the ‘No Action’ is used for comparison.

No Action

Direct Effects and Indirect Effects

Direct and indirect effects associated with not treating the units would result in slow recruitment of ground cover in areas the experienced high soil burn severity, as well as accumulation of forest material; increasing the potential for another catastrophic fire.

Streamclass	Riparian Reserve Buffer	Streamside Management Zone Buffer
Perennial	300’	The greater of 100’ slope distance or to the slope break
Intermittent	150’	The greater of 50’ slope distance or to the slope break
Ephemeral	100’	20’ (non-anadromous) 50’ (anadromous)

Cumulative Effects

The analysis of No Action Alternative is the same as the existing condition. Analysis of the No Action Alternative indicates that potential for cumulative effects is minimal to moderate.

Proposed Action

Direct Effects and Indirect Effects (Summary)

Temporary effects from this project are due to removal of vegetation, slash piling, and creation of skid trails. Use of heavy equipment may affect soil compaction and erosion. For a detailed description of the direct and indirect effects, please see the Hydrology Report.

Short-term effects of utilizing heavy equipment over a burned area may cause an increase in sediment delivery to streams. However, this work can also be beneficial especially to areas with high soil burn severity, where all groundcover have been consumed, and bare soil and widespread erosion have been observed. For logging treatments in these areas, BMP and design criteria stipulate minimum post-logging soil cover requirements, which would aid in infiltration and reduce overland flow and sediment delivery to streams.

Changes in stream temperature would likely not be measurable between the No Action and Proposed Action because vegetation burned at a high intensity do not provide much shade. While standing dead trees with no needles or leaves don't provide much shade, removal of dead trees would increase the amount of sunlight reaching the stream channel to some degree. At the same time, increased sunlight in the riparian zone would stimulate riparian vegetation growth that would likely provide more long-term stream shade compared to the standing dead trees.

Salvage in Riparian Reserves would occur, and short-term impacts such as soil compaction and erosion are likely. However, treatments to increase groundcover would also occur, and erosion and sediment delivery to streams would be reduced compared to the no-action alternative.

Cumulative Effects

For details on the Cumulative Watershed Effects (CWE) analyses please see the Hydrology Report.

While cumulative effects exceed or approach the "Threshold of Concern", it must be noted that this is due to the massive 2020 August Complex (not the difference between values in 2019 and 2020).

One watershed (Buck Rock) exceed the "Threshold of Concern," (TOC) primarily due the acres in both high and moderate Soil Burn Severity rating. The other two watersheds (Hammerhorn and Smokehouse) approaches the TOC after the 2020 fire but does not exceed the TOC. Due to known active landslides in the area, treatment units themselves were planned to avoid known and suspected unstable areas.

Changes between the No Action TOC and Proposed Action (PA) TOC are very limited, in terms of an Equivalent Roaded Acre (ERA) condition. This indicates that this project will not lead to differences in cumulative watershed effects. Erosion and sedimentation due to the fire should be very similar to what they would be without this project.

HUC 14	Alternative	TOC	2019 ERA	2020 ERA (Fire year)	2021 ERA (project Implementation)	2022 ERA	2023 ERA	2024 ERA
Buck Rock	PA	9.2	2.14	14.14	10.72	8.32	5.45	3.94
	No Act		2.14	14.14	10.72	7.90	5.07	3.60
Hammerhorn	PA	10.86	0.98	10.16	7.11	4.74	2.24	1.65
	No Act		0.98	10.16	7.11	4.61	2.12	1.55
Smokehouse	PA	11.51	1.38	10.25	7.29	4.99	2.63	2.02
	No Act		1.38	10.25	7.29	4.94	2.58	1.98

*PA=Proposed Action, No Act= No Action

Summary of Effects

The effects resulted from all alternatives proposed in this project do not exceed the Threshold of Concern with the exception of Buck Rock. While the No Action has the least cumulative effects, it is the most susceptible to catastrophic wildfires in the future. Recovery and ground cover recruitment in areas that burned with high intensity may be slow. The Proposed Action would have the more cumulative effects, but will have the most impact in reduction of fuels and recovery of watershed. Design Features, or mitigation measures, applicable to the project would help mitigate any potential effects due to project implementation. These are described in Appendix B of the Hydrology Report and are also found in the CE document.

Compliance with law, regulation, policy, and the Forest Plan

Compliance for this project include: Clean Water Act (1977), Executive Order 11988 (Floodplain Management,1977), National Forest Management Act (1976), Northwest Forest Plan (1994), Mendocino National Forest Land and Resource Management Plan (1996), Porter-Cologne Water Quality Control Act (1999), Executive Order 11990 (Protection of Wetlands, 1977), Forest Service Manual . The following were excluded because they are not affected by the project or do not apply: Coastal Zone Management Act (1972; 16 USC 1451), Wild and Scenic Rivers (1508.27 (b)(3)).

Hydrology Report

Introduction

The purpose of this document is to characterize hydrology within the Hammerhorn Campground Restoration and Salvage (Project) area and analyze any potential effects from implementing the Proposed Action. The 'no action' may be used for comparison in this analysis.

Discussions will include regulations related to hydrological resources, the affected environment, current conditions, environmental effects, and design features.

Potential effects to hydrologic resources include impacts to water quality, riparian reserves, and cumulative watershed effects. Water quality impacts will include sediment and temperature as these are parameters listed in the Total Maximum Daily Load (TMDL) and have the most potential to impact aquatic habitat. Water quantity (amount of stream flow) is not addressed since the level of thinning proposed in a water-stressed environment is not expected to have any measurable impact to the timing or magnitude of stream flows. It is expected that any additional soil moisture available will be utilized by remaining vegetation.

Purpose and need for this project can be found in the CE documents.

Proposed Actions Analyzed

The propose action include a combination of reforestation, sale of merchantable timber, planting/release, interplanting/second release/pre-commercial thinning and hazardous tree removal along roads within and leading to project area.

Additional details about the Proposed Action can be found in the CE documents.

Methodology

The analysis of alternatives is based on field observations and an assessment of the Cumulative Watershed Effects (CWE) resulting from activities planned or expected to occur under each of the alternatives.

Watershed effects as a result of the proposed action have been analyzed using the Cumulative Watershed Effect (CWE) process (as required by USDA FSH 2509.22, Soil and Water Conservation Handbook, Chapter 20- Cumulative Off-Site Watershed Effects Analysis). This analysis considers all ground-disturbing activities (past, present, and foreseeable future) including: past wildfire, prescribed fire, vegetation treatments, grazing, non-Forest Service timber activities, and roads. The analysis also considers soil burn severity of the 2020 August Complex, as well as any known timber operations on private land as a result (Emergency Timber Harvest Plans).

Spatial boundaries for the CWE analyses include 7th field (HUC 14, approximately 2,000-10,000 acres). These watersheds are 2nd to 4th order streams. Temporal Bounding of the CWE analysis considers all ground-disturbing activities in the past (up to ten years prior), present, and reasonably foreseeable future.

Scores for the CWE analysis is based on the Equivalent Roaded Acre (ERA); one unit of ERA is equal to one acre of land that is completely roaded (or compacted). In calculating ERA's, all ground disturbing activities are assigned an activity coefficient. This is due to the fact that most disturbances are a fraction of an ERA and have a recovery period. For example, a partial cut with tracked skidder has an activity coefficient of 0.18 and recovery period of 10 years. Permanent disturbances that have little to no recovery (e.g. roads and landings) have a coefficient of 1.

Initial ERA= acres of activity * activity coefficient

For subsequent years, to account for recovery:

Projected ERA= Initial ERA * 0.5^ (recovery years/ recovery half-life)

A percent disturbance for the watershed is then calculated as the %ERA:

%ERA= ERA / watershed acres * 100

This %ERA value is compared to a pre-determined Threshold of Concern (TOC); and when the %ERA is greater than the TOC, further analysis is required to determine if water yield, erosion, or sedimentation are of concern. The TOC varies with soil erodibility, geologic stability, and drainage density and is determined for each watershed. The more stable the stream is, the greater the TOC coefficient, which range from 0.08 to 0.16. If it is impractical to survey an affected stream to determine stability rating, then the watershed is assigned the lowest TOC coefficient of 0.08

Results from the Alsea Experimental Watershed (Harr et al, 1975) and Coyote Creek (Harr et al, 1979) suggest that 12 to 15 percent surface area compaction is observed to increase large stormflow peaks following timber removal.

A lower TOC used generally indicates a low risk of cumulative watershed effects. Cumulative watershed effects can be affected by watershed size. Larger watersheds have a greater “dilution” factor; such that an activity has less of an impact when compared to a smaller watershed with same activity. Analysis was completed at the 7^{th} field (approximately 2,000-10,000 acres) watershed (HUC 14).

Due to the extent and severity of the fire, TOCs are expected to exceed or approach for several years until vegetation reestablishes. Rhodes and Frissell (2016) concluded that any increases to water supply from logging would be localized and short-term and that “the maintenance of potential increases in water yield would require clearing of large percentage of forests at high frequency, on the order of 25% of watershed area every 10 years. This frequency and magnitude of forest removal would incur significant fiscal, logistical, and environmental costs”.

Affected Environment

The planning area is approximately 11,400 acres, encompassing mostly public and some private lands within the border of the Mendocino National Forest (MNF). The project is located within three 7^{th} field watersheds (HUC 14, see table 2 and figure 1). The 2020 August Complex burned within the project area, at varying degrees of severity (figure 2).

Average annual precipitation ranges from approximately 30-42 inches, depending on elevation. Precipitation occurs primarily during late fall to spring months, in the form of rain, with light amounts of snow in higher elevations. Elevation within the project area ranges from approximately 2400 to 7395 feet at the top of Hammerhorn Mountain.

Most streams within the project units are low-order (1-3) intermittent and ephemeral streams with gradients of 10% or higher and side slopes greater than 45%. These low order streams support little to no phreatophytic vegetation. True riparian vegetation, where it exists, is limited to about five to ten feet from the edge of the channel. While some of the streams are moderately sloped with cobble-to-gravel bed size and may have small floodplains, other reaches are heavily incised and unstable.

The project units encompass about **89 acres of Riparian Reserves** (RRs) and **57 acres of Streamside Management Zones** (SMZs). RRs and SMZs constitute a hierarchy of areas designed to protect water quality, aquatic and riparian habitats. The highest level of protection occurs within the SMZ, where no ground-based mechanized equipment is allowed to operate except at designated crossings.

Hydrologic Unit Codes

Watersheds in the project area are delineated in accordance with the national watershed classification system set forth by the USGS (USGS 2013). This system is a spatial hierarchy of eight nesting watershed size classes ranging from very large (greater than 100,000,000 acres) to very small (less than 2,000 acres). This classification system uses the term Hydrologic Unit Code (HUC) to describe watershed size classes (see Table 1). Watersheds are numbered as "levels", and are numbered in order from one to eight in descending size class. These HUC codes are used as watershed identifiers. Each HUC level code is a two digit number that ties to a watershed size and name. For example, Level 1 watershed is a two digit code (HUC2) whereas as level 5 is a 10 digit code, or HUC10 (Table 2). The term "watershed" is often used generically across a range of HUC levels, even though each HUC level has a specific name. For the remainder of this report, the term "watershed" refers to HUC16, as cumulative effects analysis is performed at the 7^{th} field level.

Table 1. Hydrologic Unit Code (HUC) classification system.

Watershed Level	**HUC Name**	**HUC Size (acres)**
1	Region	100,000,000 (average)
2	Sub-region	10,000,000 (average)
3	Basin	7,000,000 (average)
4	Sub-basin	450,000 (average)
5	Watershed	~40,000-250,000
6	Sub-watershed	~10,000-40-000
7	Drainage	~2,000-10,000
8	Sub-drainage	~Less than 2,000

Table 2. Hydrologic Unit Codes (HUCs) for 6^{th}, 7^{th}, and 8^{th} field watersheds in which the project area is. These codes are used as identifiers for each watershed.

<table>
<tr><td>HUC 12 Name</td><td>HUC14 Name</td><td>Acres</td></tr>
<tr><td>Rattlesnake-Middle Fork Eel River</td><td>Hammerhorn</td><td>2262</td></tr>
<tr><td rowspan="2">Beaver Creek</td><td>Buck Rock</td><td>7096</td></tr>
<tr><td>Smokehouse</td><td>4104</td></tr>
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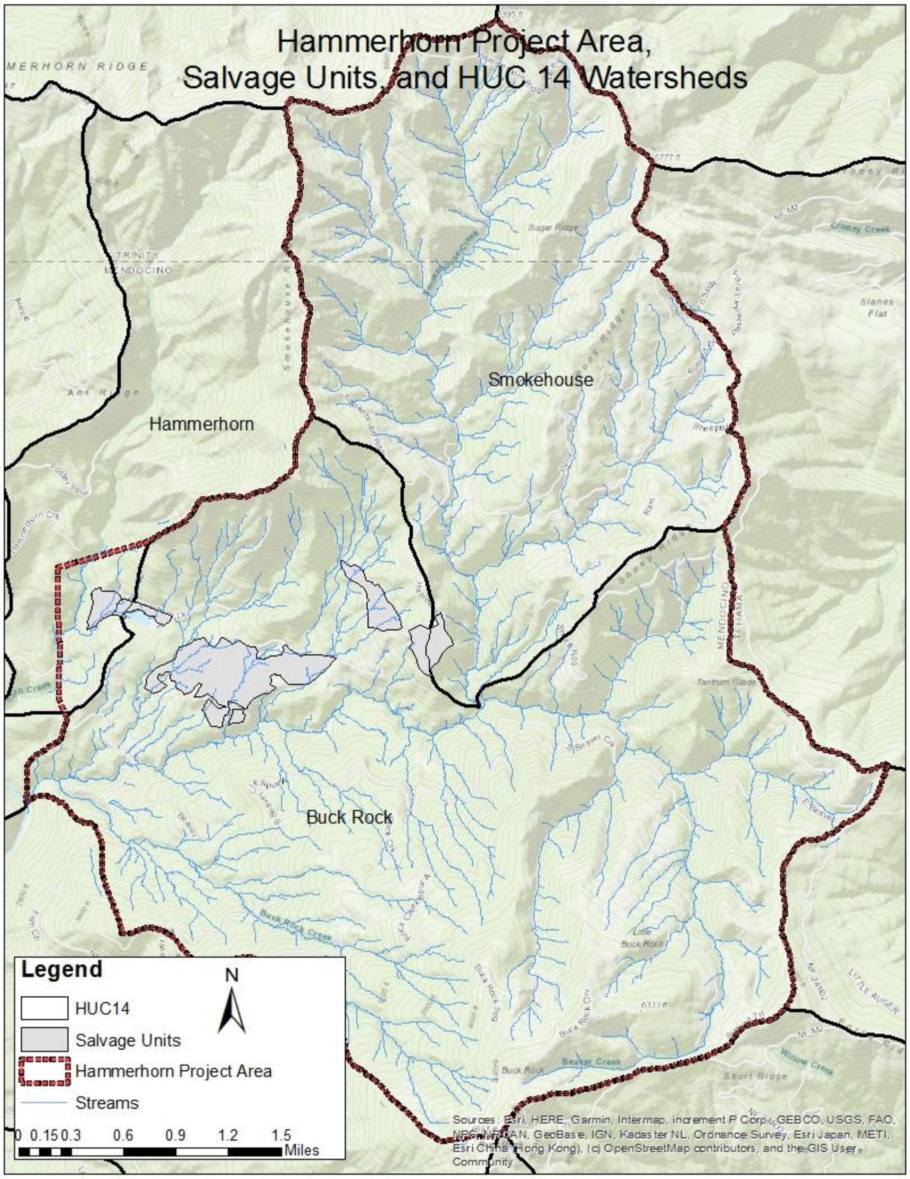

Figure 1. Project overview with watersheds (HUC 14).

Water Quality and Beneficial Uses

This project falls under the jurisdiction of the California Regional Water Quality Control Board, North Coast Region (NCWQCB), which has established beneficial uses for surface water bodies in the 2018 North Coast Regional Water Quality Control Board Basin Plan (June 2018), Middle Fork Eel River Hydrologic Area (Wilderness Hydrologic Subarea, 111.74). Beneficial uses identified include the following: Municipal and Domestic Supply, Irrigation for Agriculture, Industrial Service Supply, Freshwater Replenishment, Navigation, Hydropower Generation, Contact Recreation, Non-contact Recreation, Commercial and Sport Fishing, Warm Freshwater Habitat, Cold Freshwater Habitat, Wildlife Habitat, Rare Threatened or Endangered Species, Migration of Aquatic Organisms, and Spawning Reproduction and/or Early Development.

Water bodies downstream of the project area are identified by the state under section 303(d) of the Clean Water Act as impaired for sediment and temperature. Middle Fork of the Eel, have total Maximum Daily Loads (TMDLs) for sediment and temperature approved by USEPA.

Post-Fire Watershed Condition

The fire resulted in a range of both soil and vegetation burn severities (figure 2). Soil burn severity is a measure of the effect of ground heat as a fire burns across a landscape, and is not the same as vegetation burn severity. Vegetation burn severity measures both vegetation canopy mortality and vegetation basal area mortality resulting from wildfire. Table 3 lists percent of unburned, low, moderate, and high soil burn severities in each HUC14 watershed. Soil burn severity is important to consider from a watershed perspective because hydrophobicity is often correlated with burned soils, leading to the potential for erosion (figure 3).

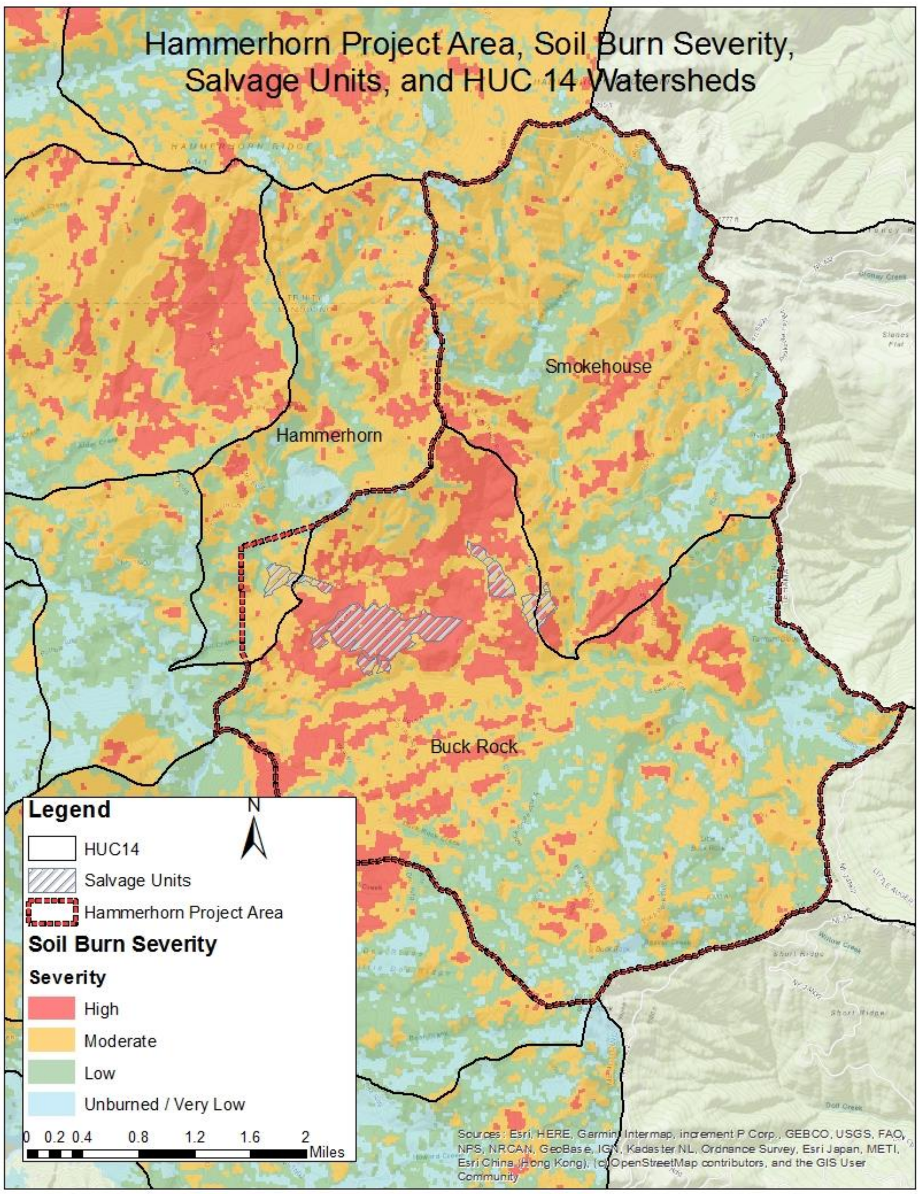

Figure 2. Soil burn severity of project area.

Figure 3. Water repellency occurring directly below approximately ½ inch of soil with impacts to soil structure and fine roots.

Table 3. Soil Burn Severity in each HUC 14 watershed (acres)

Soil Burn Severity						
Watershed	**Total Acres**	**Unburned**	**Low**	**Mod**	**High**	**%WSHD Burned**
Buck Rock	7095	534	2085	2901	1575	92
Hammerhorn	2262	127	637	1302	196	94
Smokehouse	4104	329	1239	2163	373	92

Low Soil Burn Severity Areas

Post-fire conditions in areas that burned at low soil burn severity are similar to unburned areas. Surface organic layers are not completely consumed and are still recognizable. Structural aggregate stability is not changed from its unburned condition, and roots are generally unchanged because the heat pulse below the soil surface was not great enough to consume or char any underlying organics. The ground surface, including any exposed mineral soil, may appear brown or black (lightly charred), and the canopy and understory vegetation will likely appear “green.” In general, riparian zone vegetation was not impacted in areas of low soil burn severity. See Figure 4 for an example of low soil burn severity.

Figure 4. Example of low soil burn severity. Riparian vegetation has been minimally disturbed, groundcover is present, and green and brown pine needles remain on the trees. Root structure is still intact, and ground cover still remains.

Moderate Soil Burn Severity Areas

Up to 80 percent of the pre-fire ground cover (litter and ground fuels) may be consumed but generally not all of it. Fine roots (~0.1 inch or 0.25 cm diameter) may be scorched but are rarely completely consumed over much of the area. The color of the ash on the surface is generally blackened with possible gray patches. There may be potential for recruitment of effective ground cover from scorched needles or leaves remaining in the canopy that will fall to the ground. The prevailing color of the site is often “brown” due to canopy needle and other vegetation scorch. Soil structure is generally unchanged.

Erosion and sediment deposition to streams have been observed in these areas, but has not been as widespread or severe as in areas of high burn severity. Some damage to riparian vegetation occurred, however damage is patchy and not widespread. Resprouting riparian vegetation has been observed at many locations. See Figure 5 for an example of moderate burn severity.

Figure 5. Example of moderate soil burn severity. Riparian vegetation has been consumed in some areas, but is present in other areas. Some pine needles have fallen to the ground and provided groundcover, while others have remained on the trees. Note gray and brown patches on the ground.

High Soil Burn Severity Areas

All or nearly all of the pre-fire ground cover and surface organic matter (litter, duff, and fine roots) is generally consumed, and charring may be visible on larger roots. These areas of bare ground are highly susceptible to erosion. As most if not all leaves and pine needles were consumed, there is no potential for future ground cover from needles and leaves falling to the ground (referred to as "needle cast"). With the occurrence of multiple precipitation events since the fire, rill erosion and sediment deposition in streams is present in many areas. Riparian Reserves that burned at high intensity had all groundcover, riparian vegetation, and coarse and fine woody debris consumed. Woody material within the stream channel was often consumed in areas that burned at high intensity. Resprouting riparian vegetation has been observed at many locations.

The prevailing color of the site is often "black" due to extensive charring. Bare soil or ash is exposed and susceptible to erosion, and aggregate structure may be less stable. White or gray ash (up to several centimeters in depth) indicates that considerable ground cover or fuels were consumed. Sometimes very large tree roots (> 3 inches or 8 cm diameter) are entirely burned extending from a charred stump hole. Soil is often gray, orange, or reddish at the ground surface where large fuels were concentrated and consumed. See Figure 6 for an example of high burn severity.

Figure 6. Example of high soil burn severity. All groundcover and riparian vegetation have been consumed and little to no pine needles remain on the trees. Instream large woody debris was partially or fully consumed throughout the channel. Note the sediment deposition within the stream channel as well as the large density of standing trees and potential for future high ground fuel accumulations. Note the white ash on the right-hand side picture.

Environmental Consequences

Water Quality

Erosion and Sedimentation

The impacts of salvage logging on erosion and sediment transport have been the subject of much debate (McIver and Star 2001; Beschta et al. 2004; Peterson et al. 2009). Increased sediment transport from salvage logging has been documented by multiple studies. Silins et al. (2009) found that post-fire logging created more sediment transport networks compared to areas that burned but were not logged, which is supported by the results of Wagenbrenner et al. (2015). Conversely, Chou et al. (1994) and McIver and Star (2001) detected no difference in sediment output between logged and unlogged burned areas, which they suggested was because sediment contributed by logging was overwhelmed by sediment produced from the fire itself. Peterson et al. (2009) suggested that because post-fire logging takes place in areas where the canopy and soil have already been modified, it is reasonable to conclude that logging would not add significantly to the already altered landscape.

Use of heavy equipment in logging operations can result in soil compaction, the degree of which is dependent upon site conditions such as soil moisture content and operational practices (Ares et al. 2005; Moore and Wondzell 2005; Cambi et al. 2015). As soils become compacted, the amount of water that can infiltrate the soil is reduced (Elliot 1999), which can increase surface runoff, erosion, and stream sediment delivery. Soil displacement can occur as heavy equipment moves though logging units (particularly while turning) as well as when logs are dragged across the ground (often referred to as "endlining"). Soil displacement can cause ruts that concentrate surface runoff and increase erosion and sediment delivery. Ground-based logging systems cause more compaction than skyline or helicopter logging systems (McIver and Star 2001; Beschta et al. 2004). Soil compaction can be minimized by using low ground-pressure equipment and operating equipment on dry soils.

Groundcover is an important factor in reducing erosion and sedimentation from logging operations. The presence of even a thin litter layer can substantially reduce soil erosion (Powers 2002). Salvage logging can increase soil groundcover by producing slash material that remains after logging has been completed, which creates roughness and promotes infiltration (Shakesby et al. 1996; Peterson et al. 2009; Smith et al. 2011). Wagenbrenner et al. (2015) found that adding slash to skid trails increased total groundcover by 20-30 percent and reduced sediment yield by 5-50 times compared to untreated skid trails.

Forest roads can impact watershed hydrology by concentrating and channelizing surface and subsurface flow, which can result in increased sediment delivery to streams (Foltz 1995; Luce and Black 1999). Roads are widely recognized as the largest source of erosion and sedimentation from forest practices (USDA Forest Service 2001; Akbarimehr and Haghdi 2012). Soil erosion from roads is often greatest during the first year or two following construction, before cut banks have revegetated and stabilized, which must be considered when constructing or reconstructing roads for postfire logging (Peterson et al. 2009). Road treatments such as covering roads with gravel (Brown et al. 2013, 2015) can significantly reduce road erosion and sediment delivery to streams.

The effectiveness of BMPs in reducing sediment delivery to streams from road construction and use, and logging practices in general, has been well documented (Vowell 2001; Wallbrink and Croke 2002; Rashin et al. 2006; McBroom et al. 2008; Wear et al. 2013).

Water Temperature

Stream water temperature is greatly influenced by shade from vegetation (Rutherford et al. 2004). Multiple studies have documented increased stream temperature following timber harvest due to removal of vegetation that provided shade to the stream (Bartholow et al. 2000; Rice et al. 2011). Kibler et al. (2013) found significantly higher stream temperatures in logged versus unlogged plots along 4 streams in Oregon, but did not find differences in cumulative stream temperature effects at the catchment scale.

Stream Condition

Channel Stability and Large Woody Debris

Salvage logging can remove trees that would otherwise fall into the stream channel, which can impact stream bank stability. In areas that burned at high intensity, falling snags are the only source of LWD recruitment until new trees grow large enough to fall into streams (Reeves 2006), which may take decades to centuries (Beechie 2000). Large down wood within riparian zones is also important as it provides habitat (Bisson et al. 2003; Dunham 2003) and traps fine sediment before it erodes into stream channels (Wondzell and King 2003). Following high intensity burns in riparian areas, the removal of streamside vegetation and groundcover leaves the area susceptible to increased overland flow, which can concentrate flow and accelerate velocity that results in increased bank erosion and impacts to stream channel stability. Salvage logging has potential to reduce overland flow and thus increase channel stability by increasing groundcover and dropping and leaving large trees on the ground as well as in or adjacent to the stream channel that could otherwise take years to fall.

Stream Flow

Removal of vegetation has potential to impact streamflow (Moore and Wondzell 2005). Removal of live vegetation decreases water use due to reduction in transpiration and can thus increase water yield, however the impacts are generally not detectible unless 20-40 percent of a watershed is harvested (Peterson et al. 2009). Changes to water yield are generally greatest in the first year following vegetation removal, then decrease over time as vegetation recovers. Because salvage logging generally removes trees that are already dead, it is not likely that removal of dead trees would further impact any changes to water yield (Peterson et al. 2009). Peak flow rates can also increase after logging activities due to increased overland flow. In burned landscapes, increased groundcover from logging activities can reduce peak stream flows by increasing surface roughness and infiltration (Smith et al. 2011).

Riparian Reserves

Salvage logging of riparian areas has been the subject of much debate (Beschta et al. 2004; Reeves et al. 2004; Peterson et al. 2009). Logging within RRs can negatively impact riparian zones due to compaction and soil displacement from heavy machinery, and result in increased erosion and sediment delivery to streams. Peterson et al. (2009) suggest that short term effects of salvage logging near aquatic systems are mostly negative, and adverse effects of salvage logging to aquatic habitat have been widely documented.

Conversely, removal of large trees, particularly those that have retained needles, can increase sunlight that often stimulates regrowth of riparian vegetation. Riparian vegetation is often resilient even following wildfires (Ellis 2001; Dwire and Kauffman 2003; Beschta et al. 2004) and resprouting riparian vegetation such as willows and sedges is often observed quickly after the fire. Reeves et al. (2006) suggest that management activities that compliment ecosystem recovery processes may help minimize long-term damage to aquatic ecosystems, and McIver and Star (2001) suggest that post-fire logging can target certain ecological benefits. For example, and as discussed above, salvage logging can increase soil groundcover by producing slash material that can reduce erosion and sediment delivery to streams (Shakesby et al. 1996; Peterson et al. 2009; Smith et al. 2011) as well as reduce reburn potential and resultant impacts to watershed function and aquatic ecosystems (DeBano et al. 1998; Brown et al. 2003; Peterson et al. 2009; Johnson et al. 2013).

No Action

Direct Effects and Indirect Effects

<u>Water Quality</u>

Erosion and Sedimentation

Ground disturbance from mechanized equipment and associated increases in erosion and sedimentation would not occur under Alternative 1. Increased soil erosion and stream sediment delivery would likely occur for the next 1-5 years as a result of the fire itself, depending on location and burn severity. In areas of low burn severity, hydrophobic soils would be localized, and groundcover would recover quickly due to litterfall and reestablishment of vegetation. Erosion and sedimentation from these areas would be limited. Increased erosion and sediment delivery would likely occur from areas of moderate burn severity, however recovery of vegetation and groundcover would occur in approximately 2-3 years. High severity burn areas would have the greatest increases in erosion and sediment delivery to streams due to more persistent soil hydrophobicity and complete consumption of groundcover. Groundcover would be slow to reestablish as all pine needles and branches were consumed in the majority of areas of high burn intensity. Increased erosion and sediment delivery in areas of high burn severity would be expected to persist for up to 5 years, although even longer recovery times are possible in some areas.

No groundcover treatments would occur under the No-Action. Without such treatments, increases in groundcover would be slower to occur, particularly in areas of high burn severity where all pine needles and leaves were consumed. Lack of groundcover treatments in RRs (but outside of mechanical exclusion zones) would be of particular concern to hydrologic resources due to degraded conditions currently present in RRs that burned at high intensity. Establishment of a dense shrub component occurs naturally following wildfires, and this increase in groundcover would minimize erosion and sedimentation over time, however it would not provide a substantial increase in groundcover the first few years following the fire.

While ground disturbance from mechanized equipment would not occur under the No-Action, actions to reduce existing erosion would also not occur. Existing disturbances such as old skid trails and landings would not occur. Erosion and sediment transport from these areas would continue and likely be exacerbated from the impacts of the fire. Further, no road repair or maintenance would occur under Alternative 1, and erosion and sediment delivery to streams would continue from roads that are not functioning appropriately.

Water Temperature

No impact to water temperature is anticipated under Alternative 1. Due to removal of streamside vegetation by the fire, elevated stream water temperatures would likely continue until vegetation becomes reestablished.

<u>Stream Condition</u>

Stream Morphology and Large Woody Debris

Channel stability would increase over time as near-stream vegetation recovers and standing dead trees fall in or adjacent to the stream channel. Recovery of channel stability would be slow due to complete or near-complete consumption of riparian and streamside vegetation in areas that burned at high intensity. In streams with high levels of LWD and an abundance of snags near streams, additional inputs may lead to log jams that form dams which would not allow for proper sediment transport and function. Stream channel improvements, including additions of large wood and stabilization of streambanks, would also not occur.

Stream Flow

Streamflow has likely increased due to reduced transpiration and soil water infiltration, increased overland flow, and consumption of riparian vegetation and instream LWD that can reduce velocity during high stream flows. Peak stream flows in particular have likely increased and would continue to remain high until riparian vegetation recovers, soil hydrophobicity declines, and groundcover increases. Streamflow would return to within the natural range of variability in 1-5 years as transpiration increases as vegetation recovers, and as overland flow is reduced.

<u>Fuel Loading</u>

The no-action alternative would result in high future surface fuel loading both in upland and riparian zones throughout the project area, particularly in areas of moderate and high burn severity where dead and damaged trees are likely to fall over time. If a future fire were to occur, areas with large surface fuel loading would likely burn at high intensity and soils would be susceptible to widespread damage. High surface fuel loading and potential for high burn intensities within RRs are of particular concern with respect to hydrologic and aquatic resources. The lost opportunity to reduce fuel loading has the potential to affect riparian habitat and water quality. It has been documented that wildfires can produce accelerated erosion to the watershed (Shakesby et al. 1993; Benvaides-Solorio and MacDonalds, 2001).

Riparian Reserves

Logging would not occur within RRs under the No-Action, and there would be no potential for ground disturbance from heavy machinery. However, treatments to increase groundcover would not occur and RRs that burned at high intensity would remain susceptible to increased erosion and sediment delivery to streams. Treatments to obliterate existing disturbances within RRs would also not occur and these areas would continue to route sediment to streams.

Cumulative Effects

Cumulative watershed effects (CWEs) were assessed using the Equivalent Roaded Acres (ERA) methodology (detailed description in Methods section of this report). Briefly described, the ERA method considers roads as the greatest potential to increase runoff and sediment delivery to streams. The CWE model calculates the percent of a watershed that is covered in the “equivalent” of roads, which is then compared to a Threshold of Concern (TOC) above which there is potential for measurable cumulative watershed effects. It is important to note that the TOC is not an exact point at which cumulative watershed effects will occur, or even that measureable effects will occur at all, it is merely a warning that cumulative effects *might* occur.

The analysis of the No Action is considered the same as the existing condition. Analysis of the No Action indicates that potential for cumulative effects is moderate in 2021, largely due to the 2020 August Complex. Watersheds in the project area currently are below threshold for the No Action, with the exception of Buck Rock (Table 4). This watershed experienced 92% of its watershed burned, mostly at the moderate soil burn severity (Table 3).

Table 4. Cumulative Watershed Effects analysis.

HUC 14	Alternative	TOC	2019 ERA	2020 ERA (Fire year)	2021 ERA (Project Implementation)	2022 ERA	2023 ERA	2024 ERA
Buck Rock	PA	9.2	2.14	14.14	10.72	8.32	5.45	3.94
	No Act		2.14	14.14	10.72	7.90	5.07	3.60
Hammerhorn	PA	10.86	0.98	10.16	7.11	4.74	2.24	1.65
	No Act		0.98	10.16	7.11	4.61	2.12	1.55
Smokehouse	PA	11.51	1.38	10.25	7.29	4.99	2.63	2.02
	No Act		1.38	10.25	7.29	4.94	2.58	1.98

*PA=Proposed Action, No Act=No Action

Proposed Action

Direct and Indirect Effects

Water Quality

Erosion and Sedimentation

Short-term ground disturbance such as compaction and displacement would occur under the proposed action with use of heavy equipment. Previous research has demonstrated that salvage logging can increase sediment routing to streams due to construction and use of skid trails and landings as well as use of heavy machinery to cut and remove trees. Increased sediment delivery to streams as a result of salvage logging can increase stream turbidity, which can impact the beneficial uses of water (see beneficial uses, under the Affected Environment section). However, implementation of BMPs and project design criteria would reduce potential for impacts to water quality.

While short-term impacts are likely under the proposed action, it would also promote long-term soil and hydrologic recovery of burned areas. For example, the majority of areas that burned at high intensity had all groundcover consumed, and bare soil and widespread erosion and sediment delivery to streams has been observed. For the logging treatments proposed under the proposed action, design criteria stipulate minimum post-logging soil cover requirements, which would aid in infiltration and reduce overland flow and sediment delivery to streams. Natural recovery of groundcover in areas that burned at high intensity would be slower without treatments proposed as there are no pine needles, leaves, or small branches to fall to the ground. Best management practices would also require construction of waterbars, and subsoiling when appropriate, which would reduce potential for sediment from logged areas reaching streams.

Water Temperature

Compared to no action, changes to stream water temperature would likely not be measurable under the Proposed Action, although reforestation would promote recovery of stream shade in the long term. With respect to stream shade, there is a tradeoff with removing dead trees. While standing dead trees with no needles or leaves don’t provide much shade, removal of dead trees would increase the amount of sunlight reaching the stream channel to some degree. At the same time, increased sunlight in the riparian zone would stimulate riparian vegetation growth that would likely provide more long-term stream shade compared to the standing dead trees.

Stream Condition

Stream Geomorphology and Large Woody Debris

Removal of trees within Riparian Reserves would reduce potential for trees falling into streams that would improve bank stability. Due to near-stream exclusion zones, a more than sufficient number of trees would be retained to provide for future recruitment. Project design criteria also require minimum levels of coarse woody debris throughout the Riparian Reserve to provide habitat and disrupt surface erosion pathways.

Stream Flow

The proposed action may have a slight but likely immeasurable impact to streamflow relative to the no-action. Streamflow has likely increased as a result of the fire, but would return to within the natural range of variability in 1-5 years as transpiration increases as vegetation recovers, and as overland flow decreases. The removal of trees under the project would not impact transpiration rates as the trees are already dead and not transpiring. Increasing groundcover however would likely reduce peak streamflows after precipitation and snowmelt events due to increased infiltration and reduced overland flow.

<u>Fuel Loading</u>

Fuel loading would be impacted by implementation of the proposed project. Fuel loading would increase initially due to logging slash material and large down wood requirements. However, long-term fuel loading and potential for high intensity reburn would decrease. Compared to the No-Action, there would be lower potential for a high intensity burn to occur in response to the proposed treatments.

<u>Riparian Reserves</u>

Logging in Riparian Reserves would occur under the project, and short-term impacts such as soil compaction and erosion are likely. However, treatments to increase groundcover would also occur, and erosion and sediment delivery to streams would be reduced compared to the no-action alternative.

Cumulative Effects

While cumulative effects exceed or approach the “Threshold of Concern” when analyzed under the Cumulative Watershed Effects model, it must be noted that this exceedance is primarily due to the 2020 August Complex.

Changes between the No Action TOC and Proposed Action TOC are not very large for most watersheds, indicating that this project will not lead to cumulative watershed effects. All watersheds will drop well below TOC, by 2023, primarily due to vegetation recovery (table 4). Hammerhorn had the highest TOC exceedance due to the August Complex in this project.

Erosion and sedimentation should be very similar to what they would be without this project. These results are consistent with the results of Chou et al. (1994) and McIver and Star (2001), who found no differences in sediment output between logged and unlogged burned areas, which they suggested was because sediment produced from logging was overwhelmed by sediment produced from the fire itself.

Since the canopy was already removed by the fire, and no live vegetation will be removed from riparian reserves, this project will have no effect on stream temperature. Cumulative watershed effect analysis for the proposed project also agrees with Peterson et al. (2009), who in a synthesis of the effects of post-fire logging in western North America, suggested that because post-fire logging takes place in areas where the canopy and soil have already been modified, it is reasonable to conclude that logging would not add significantly to the already altered landscape.

Project design criteria and BMPs would be expected to reduce potential CWEs from proposed activities to the extent possible. As required by the North Coast Waterboard permit process, monitoring would occur in the watersheds treated under this alternative. The results of this monitoring would be used to determine effectiveness of design criteria and BMPs, and appropriate actions would be taken if monitoring reveals that thresholds set forth in the monitoring plan have been exceeded.

Compliance with law, regulation, policy, and the Forest Plan

Clean Water Act of 1948 (as amended in 1972 and 1987): establishes as federal policy the control of point and non-point pollution and assigns the States the primary responsibility for control of water pollution. Compliance with the Clean Water Act by National Forests in California is achieved under state law (see below).

The California Water Code: consists of a comprehensive body of law that incorporates all state laws related to water, including water rights, water developments, and water quality. The laws related to water quality (sections 13000 to 13485) apply to waters on National Forests and are directed at protecting the beneficial uses of water. Of particular relevance is section 13369, which deals with nonpoint-source pollution and BMPs.

The Porter-Cologne Water-Quality Act, as amended in 2006: is included in the California Water Code. This act provides for the protection of water quality by the State Water Resources Control Board and the Regional Water Quality Control Boards, which are authorized by the U.S. Environmental Protection Agency to enforce the Clean Water Act in California.

Regional Water Quality Control Boards: are the primary regulatory agencies for water quality in California. This project falls under the jurisdiction of the North Coast Regional Water Quality Control Board (NCRWQCB). Each Regional Board has a Basin Plan that includes identified beneficial uses and water quality objectives (standards) for water bodies within each region. Basin Plans may include prohibitions of pollutant discharges, and are incorporated into the California Water Code. As such, Basin Plans are enforceable laws. Regional Boards may establish Timber Waivers that regulate vegetation management activities on National Forests. Timber Waivers include conditions and requirements for reporting and monitoring. To be eligible for coverage under this waiver, the project must meet the definition of timber harvest activities, and comply with all of the applicable eligibility criteria and conditions. Eligibility criteria for a Timber Waiver are:

- USFS has conducted a multi-disciplinary review of the timber harvest proposal, including review by watershed specialists, and has specified BMPs and additional control measures as needed, in order to assure compliance with applicable water quality control plans.
- USFS has conducted a CWE analysis and included specific measures needed to reduce the potential for CWEs in order to assure compliance with applicable water quality control plans.
- USFS has allowed the public and other interested parties reasonable opportunity to comment on and/or challenge individual timber harvest proposals.

National Forest Management Act 1976: recognizes the fundamental need to protect, and where appropriate improve, the quality of soil, water, and air resources. With respect to water and soils, NFMA requires that the Forest Service manage lands so as not to impair their water quality and long-term soil productivity. Further, activities must be monitored to ensure that productivity is protected. This law led to subsequent regulation and policy to execute the law at various levels of management.

The Northwest Forest Plan (NWFP): the Record of Decision (ROD) for the 1994 NWFP includes standards and guidelines that apply to management of Riparian Reserves (RRs). NWFP standards and guidelines require the Forest Service to analyze potential effects of management activities proposed for RRs prior to implementation.

Mendocino National Forest Land and Resource Management Plan (LRMP): include standards and guidelines that apply to specific activities. LRMPs may not be less protective of riparian resources than the NWFP.

The Forest Service Manual (FSM): provides agency guidance for salvage harvests and protection of riparian areas. Directives for salvage sales are included in FSM 2435. Directives for riparian area management are provided in FSM 2526, which requires that riparian areas shall be managed under the principle of multiple-use and sustained-yield, with emphasis on protection and improvement of soil, water, and vegetation. Directives for water-quality management are provided in FSM 2532, which requires that BMPs be applied to all management activities.

Executive Order 11988 (Floodplain Management): requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

Executive Order 11990 (Protection of Wetlands): purpose is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands"

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Appendix A- Compliance Check with LRMP

Standards and Guides

The following checklist covers the LRMP Standards and Guides with which projects and activities must comply regarding the resources normally evaluated by the hydrologist. Information is provided regarding project design elements and resource conditions which affect the project's or activity's compliance with the Standards and Guides.

Watershed & Water Quality (Pages IV - 40, 41)		
S&G #	**Requirement**	**Project Compliance**
1a.	Within all watersheds, identify depleted watershed areas during the project environmental assessment process. Incorporate improvement activities as a part of the project.	After the 2020 August Complex, many of the watersheds within the project area experienced higher runoff and sedimentation due to post fire conditions. However, experiences in the 2018 Ranch Fire, significant vegetative recovery was noticed in 2020, and the proposed project will continue to aid in that recovery, as well as help prevent another major loss of vegetation due to a major fire (by reducing fuels and maintaining a regular fire return interval).
1c.	Within all watersheds, analyze projects that propose land disturbing activities for their effects on the appropriate level of watershed (normally second to fourth order watersheds) in order to prevent excessive cumulative watershed effects on stream channel condition and water quality. Cumulative watershed effects (CWE) analysis will be used to gauge impacts of past, present, and proposed management activities on a watershed.	CWE's were analyzed according to the ERA methodology (which includes past, present, and proposed activities). Cumulative activities within 7^{th} field watersheds remain below Threshold of Concern with the exception of Buck Rock. Watershed return to well-below TOC by 2023.
1d.	Within all watersheds, implement Best Management Practices (BMP) to meet water quality objectives and maintain and improve the quality of surface water on the Forest. Identify methods and techniques for applying the BMPs during project level environmental analysis and incorporate them into the associated project plan and implementation documents.	BMPs prescribed in Appendix B of the Hydrology report are based on field review of the units.

Watershed & Water Quality (Pages IV - 40, 41)		
S&G #	**Requirement**	**Project Compliance**
Riparian and Aquatic Ecosystems Pages (IV 30-33)		
	Requirement	**Project Compliance**
1a.	Maintain and restore the distribution, diversity and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted.	This project will help achieve these values and objectives by reducing fuels and maintaining a regular fire return interval. Design Features will require a minimum ground cover, which will be beneficial for areas of high soil burn severity (where all ground cover was consumed by the fire)
1b.	Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.	This project is not anticipated to have a negative effect on spatial or temporal connectivity between watersheds. The proposed project will have limited activities (and no equipment entry) within Streamside Management Zones.
1c.	Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.	There are no anticipated negative effects to these values by the proposed action. Heavy equipment would be buffered from streams during thinning.
1d.	Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.	This project will help increase ground cover and reduce surface erosion. Heavy equipment would be buffered from streams. Crossings have been designated and are determined to be low impact.
1e.	Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.	This project will help increase ground cover and reduce surface erosion. Heavy equipment would be buffered from streams. Crossings have been designated and are determined to be low impact.
1h.	Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and	These values would be maintained and/or restored. The work would not take the RR vegetation outside the natural range, but rather help reduce (and prevent) future wildfire

Watershed & Water Quality (Pages IV - 40, 41)		
S&G #	**Requirement**	**Project Compliance**
	distributions of coarse woody debris sufficient to sustain physical complexity and stability.	effects. The proposed action will help achieve these values and objectives by reducing fuels and returning fire to areas where fire has been suppressed through several fire return intervals. Alternative 1 “No Action” would fail to yield these benefits.
1i.	Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.	The purpose of this project will maintain the limited true riparian habitat within the project boundaries and help protect it from future wildfire. Project activities along streams and around springs are expected to result in improved riparian habitat.
3b.(2)	In Riparian Reserves, do not use mitigation or planned restoration as a substitute for preventing habitat degradation.	Mitigation is not being substituted for prevention of habitat degradation; there are no proposed actions to degrade habitat in Riparian Reserves.

Appendix B- Project Design Features and Best Management Practices

Forest management and associated road building in the steep rugged terrain of forested mountains has long been recognized as sources of non-point water quality pollution. Non-point pollution is not, by definition, controllable through conventional treatment means. It is controlled by containing the pollutant at its source, thereby precluding delivery to surface water. Sections 208 and 319 of the Federal Clean Water Act, as amended, acknowledge land treatment measures as being an effective means of controlling non-point sources of water pollution and emphasize their development.

The Forest Service have developed and documented non-point pollution control measures to National Forest System lands. These measures were termed “Best Management Practices” (BMPs) and are designed to accommodate site specific conditions. They are tailor-made to account for the complexity and physical and biological variability of the natural environment.
The following BMP’s have been identified to address watershed management concerns. These BMPs come from the 2012 Forest Service publication “National Best Management Practices for Water Quality Management on National Forest System Lands.” The implementation monitoring is done after the project has been completed, but before the winter season. Effectiveness monitoring is then completed on year later to determine success of BMP implementation.
All work and hauling should be done outside of the rainy season when soils are dry and potential damage to roads are minimized.

Chem 3 (Chemical Use Near Waterbodies)
<u>Objective</u>- Avoid or minimize risk of chemical delivery to surface water or groundwater when treating areas near waterbodies.

<u>Application</u>- Some chemicals used in terrestrial applications are toxic to aquatic flora and fauna, any overly enrich aquatic systems, and may pose a human health hazard if drinking water sources are contaminated during or after chemical applications.
To help protect surface waters and wetlands from contamination, a buffer zone of land and vegetation adjacent to the waterbody will be designated. Spill contingency plan would also be implemented if a spill occurs.

Chem 5 and Road 10 (Chemical Handling and Disposal/ Equipment Refueling and Servicing)
<u>Objective</u>
Chem 5- Avoid of minimize water and soil contamination when transporting, storing, preparing, and mixing chemicals; cleaning equipment or disposing chemical containers.
Road 10- Avoid or minimize adverse effects to soil, water quality, and riparian resources from fuels, lubricants, cleaners, and other harmful materials discharging into nearby surface waters or infiltrating through soils to contaminate groundwater resources during refueling and servicing activities.

<u>Application</u>- Handling chemicals, chemical containers and equipment (including petroleum-based) can lead to contamination of surface water or groundwater if not done carefully. Spills, leaks, or wash water can contaminate soil and leech into groundwater. Residue left on containers or equipment can wash off during precipitation events and enter surface waters.

Containers should be inspected on a regular basis to ensure no leaks, and stored away from riparian reserves. Spill kits should be available in case of an accidental spill. All waste should be disposed of according to state, federal and local regulations.

Road 4 (Road Operations and Maintenance)
Objective- Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by controlling road use and operations and providing adequate and appropriate maintenance to minimize sediment production and other pollutants during the useful life of the road.

Application- Consideration is given to the potential water quality effects from road damage when oversize or overweight loads are driven over forest roads. Roads should be routinely inspected to ensure they are not being impacted by log trucks. Water all dirt roads to minimize dust.

Veg 2 (Erosion Prevention and Control)
Objective- Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources by implementing measures to control surface erosion, gully formation, mass slope failure, and resulting sediment movement before, during, and after mechanical vegetation treatments.

Application- The process of erosion control has three basic phases; planning, implementation, and monitoring. During planning, areas subject to excessive erosion, detrimental soil damage and mass failure can be identified and avoided. Suitable erosion control measures are implemented while the maintenance of implemented measures will ensure their function and effectiveness over their expected design period.

The potential for accelerated erosion or other soil damage during or following mechanical treatments depends on climate, soil type, site conditions, and type of equipment and techniques used at the site. Erosion control measures are grouped into two general categories: structural measure to control and treat runoff and increase infiltration and nonstructural measures to increase ground cover.

Veg 3 (Aquatic Management Zone) (also Riparian Reserves and Streamside Management Zones)
Objective- Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when conducting mechanical vegetation treatment activities in AMZ.

Application- Designation of an AMZ around and adjacent to waterbodies is a typical BMP to avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources. Mechanical vegetation treatments are a tool that can be used within the AMZ to achieve a variety of resource-desired conditions and objectives when implemented with suitable measures to maintain riparian and aquatic ecosystem structure, function, and processes. Depending on site conditions and resource-desired conditions and objectives, mechanical vegetation treatments in AMZ could range from no activity or equipment exclusion to purposely using mechanical equipment to create desired disturbances or conditions. When treatments are to be used in AMZ, a variety of measures can be employed to avoid, minimize, or mitigate soil disturbance, damage to waterbody, loss of large woody debris recruitment, and shading, and impacts to floodplain function.

Veg 4 (Ground-Based Skidding and Yarding Operations)
Objective- Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources during ground-based skidding and yarding operations by minimizing site disturbance and controlling the introduction of sediment, nutrients, and chemical pollutants to waterbodies.

Application- Ground-based yarding systems include an array of equipment from hoses, rubber-tired skidders, and bulldozers, to feller or bunchers, forwarders, and harvesters. Each method can compact soil and cause soil disturbance, though the amount of impact depends on the specific type of equipment used, the operator, unit design, and site conditions. Ground-based yarding systems can be designed and implanted to avoid, minimize, or mitigate potential adverse effects to soils, water quality, and riparian resources.

Veg 6 (Landings)
Objective- Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources from construction and use of log landings.

Application- Landings are generally sites of intense activity, with lots of equipment working in these concentrated areas. Chemicals and fuels are often stored at these locations to service equipment, leaving a high probability of soil compaction, overland flow, and soil contamination. Any chemical and fuel containers should be disposed of appropriately, in addition to any refuse (tires, chains, chokers, cables, and miscellaneous discarded parts). Contaminated soils should also be disposed appropriately. Provide ground cover where necessary to prevent erosion.

WatUse3 (Administrative Water Development)
Objective- Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when developing and operating water sources for Forest Service administrative and resource management purposes.

Application- Water source developments are needed to supply water for a variety of Forest Service administrative and resource management purposes, including dust control. Locations used for drafting should be preexisting locations, such as any of the boat ramps along Lake Pillsbury or under the bridge of M1, below Scott Dam. Utilizing a high volume pump will help prevent water trucks from having to back down into water (which could have an effect of water quality if the truck has a leak).

Road 7- Stream Crossings
Objective- Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources when constructing, reconstructing, or maintaining temporary and permanent waterbody crossings.

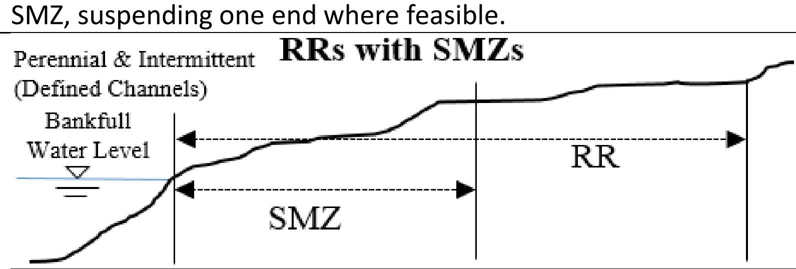
Application- Construction, reconstruction, and maintenance of a crossing usually requires heavy equipment to be in and near streams, lake, and other aquatic habitats to install or remove culverts, fords, and bridges, and their associated fills, abutments, piles, and cribbing. Such disturbance near the waterbody can increase the potential for accelerated erosion and sedimentation by altering flow paths and destabilizing streambanks or shorelines, removing vegetation and ground cover, and exposing or compacting the soil. Use of heavy equipment has a potential for contaminating the surface water form vehicle fluids or introducing aquatic nuisance species.

BMP Checklist

This checklist was created as an easy way to ensure all BMP's are followed. BMP's have been characterized for applicability for pre, during, and post project. (check boxes for each stage, greyed out boxes do not apply to that stage).

Pre	During	Post	BMP
			Chem 3- Chemical Use Near Waterbodies
			Implement the chemical spill contingency plan elements within the project safety plan if a spill occurs.
			Buffer of 10 feet when applied near any surface water
			Road 10- Equipment Refueling and Servicing/ Chem 5- Chemical Handling and Disposal
			Allow refueling and servicing only at locations well away from water or riparian resources.
			Transport and handle chemical/fuel containers in a manner that prevents leaks and spills.
			Inspect, secure, and check containers regularly.
			Store any chemicals, including fuels, outside of Riparian Areas. Install contour berms and trenches around vehicle service and refueling areas, chemical storage and use areas, and waste dumps to fully contain spills if necessary.
			Have spill kit or containment device on hand.
			Dispose of containers and contaminated soils appropriately from NFS lands.
			Report spills and initiate appropriate clean-up action in accordance with applicable State and Federal laws, rules and regulations.
			Road 4- Road Operations and Maintenance
			Water all dirt roads used for hauling.
			Inspect roads/haul routes frequently to ensure roads are not being impacted by log trucks.
			Restrict use or modify route if road is being damaged, such as unacceptable surface displacement or rutting.
			Roads used for hauling will be graded.
			Veg 2- Erosion Prevention and Control
			No ground-based mechanical equipment entry into unstable areas (unstable riparian reserves), such as active landslides and inner gorges. Inner gorges are 65% and above slopes immediately adjacent to stream beds. They extend up slope until a slope break where slopes are less than 65% or at ridge top.
			Leave felled hazard trees if fuels density meets objectives.
			All water control features (especially on roads) must be repaired and in working condition post-haul or prior to big storms.
			Use existing landings where possible. New landing construction should follow Veg 6 practices.
			No ground equipment on road cuts/road fills over 25% slope.
			Veg 3- Aquatic Management Zones (Riparian Reserves and Streamside Management Zones, RRs and SMZs)

			Retain all riparian-associated vegetation within the SMZs and RRs of seeps, springs, and unstable areas.
			Crossings of streams must be approved by the district hydrologist or fish biologist.
			Tractor piling is not permitted within RRs or SMZs.
			Cover bare soil areas that exceed 50 sq ft with mulch or slash if the area is likely to deliver sediment to a stream.
			For RRs: On slopes <50%, retain at least 50% ground cover (litter, duff, rocks) evenly distributed across the treatment area. For slopes >50%, retain at least 70% ground cover.
			SMZs have been identified and will be marked in the field with blue/white stripe flagging prior to implementation.
			For SMZs: Retain at least 70% ground cover (litter, duff, rocks) evenly distributed across the treatment area.
			For SMZ: <u>No ground-based mechanized equipment will be allowed in SMZ</u>.
			For SMZ: Trees cut in the SMZ must be felled toward the RR. If it is necessary to remove the tree, it should be end lined or grapple skidded from outside of the SMZ, suspending one end where feasible.



RR and SMZ width for each streamclass: (*Numbers are for EACH side)		
Streamclass	Riparian Reserve Buffer	Streamside Management Zone Buffer
Perennial	300 feet	The greater of 50’ slope distance or to the slope break
Perennial Fish Bearing	300 feet	The greater of 100’ slope distance or to the slope break.
Intermittent	150 feet	The greater of 50’ slope distance or to the slope break
Ephemeral	100 feet	The greater of 50’ slope distance or to the slope break

Veg 4- Ground-Based Skidding and Yarding Operations

			Utilize previously created skid trails where possible to minimize new ground disturbance.
			Locate skid trails outside of the SMZ to the extent practicable.
			Locate skid trails to avoid concentration runoff and provide breaks in grade. Avoid long run on steep slopes.
			Limit the grade of constructed skid trails on geologically unstable, saturated, highly erodible, or easily compacted soils.

			Prohibit equipment in designated SMZ’s. Material may be removed from this zone; however, heavy equipment is excluded and would require review and approval by District or Forest Hydrologist for entry.
			While restoring skid trails, place appropriate water bars to prevent sedimentation. Provide slash cover where applicable.
			In **Riparian Reserves**, fell only trees necessary to meet project objectives. When felling trees, retain the highest stump possible.
			Mechanical operations should occur during dry soil conditions; typically May 15-October 15. Operating during these times will minimize impact and reduce the potential for increased erosion.
			Ground-based heavy equipment will be limited to stable slopes less than 35%. Occasional use on stable slopes up to 40% for a distance not to exceed 100 feet is acceptable.
			Retain at least 50% ground cover (litter/duff/rock) across **all treatment areas**. Retention and even distribution of fine vegetation (rather than rocks) should be favored for ground cover and nutrient cycling.
			Fall merchantable trees perpendicular to roads to minimize the skidding lengths.
			Align non merchantable hazards trees along the contour to create erosion control, if possible, given safety considerations.
			Preference for utilizing <u>tracked</u> feller bunchers.
			Maintain ALL live or possible re-spurouting vegetation for stability.
			Any soil displacement caused by the mechanical equipment greater than 4 inches in depth would be back bladed or water-barred to prevent water concentration.
			Remove any material resulting from project activities causing obstruction of stormflows, (immediately upstream of culverts).
			Ensure recognition and protection of areas related to water quality protection delineation on Sale Area Maps. The sale administrator and purchaser will review these areas on the ground prior to commencement of ground disturbing activities. Examples of water quality protection features that will be designated on the project map include: 1) Location of streamcourses and riparian reserves to be protected 2) Wetlands (meadows, lakes, springs, etc.) to be protected. 3) Unstable areas to be protected.
Veg 6- Landings			
			Remove all logging machinery refuse (tires, chains, chokers, cables, and miscellaneous discarded parts).
			Install any suitable drainage features to prevent erosion.
			Provide ground cover where needed.
Water Use 3- Administrative Water Developments			
			Water will not be drafted from project-area streams
			Below 4.0 cfs, drafting rates should not exceed 20 percent of surface flows.
			Draft from existing locations/approaches.

			Follow Road 10/Chem 5 to prevent contamination of fuels and chemicals into waterways.
			Water-drafting vehicles shall contain petroleum spill kits. Dispose of absorbent pads accordingly.
			Road 7. Stream Crossings
			Cross small streams (width-wise) and ephemeral or intermittent streams where possible.
			Utilize previous crossings, if appropriate.
			Cross stream directly, not at an angle.
			Cross streams where the stream bottom is stable and the banks are low and intact. If stream bottom is not 'hard', consider reinforcement with rock (including approaches).
			Long approaches to the crossing should have runoff/sediment control (divert water off the road onto the forest floor)
			Where possible, install an appropriate structure (bridge, culvert, pole ford, etc) to minimize rutting and erosion.
			For Culverts, minimum size should be 18 inches and extend a minimum of one foot beyond the upstream and downstream tow of backfill placed around the culvert. Length should not exceed 40 feet. Filter Cloth: place filter cloth on the streambed and stream banks before installing the culvert and backfill. The filter cloth should extend a minimum of six inches and maximum of one foot past the toe of the backfill. Culvert placement: The culvert should be installed on the natural stream bed grade Backfill: No earth or fine-gran soil backfill should be used for temporary culvert crossings. Backfill should be clean, coarse gravel.
			If no structures or reinforcement are in place, stagger tire tracks to minimize rutting.
			Construct stream crossings during low flow periods.
			Monitor stream crossing structures during the timber harvest for plugging.
			Removal of crossing (if it has a chance for plugging) prior to winter or large incoming storms. Ensure waterbars are in place to divert water. Slash where appropriate.